Executive Summary

EX

Purpose of this Report

The Lawrence Livermore National Laboratory (LLNL) annual *Environmental Report,* prepared for the Department of Energy (DOE) and made available to the public, presents information that demonstrates compliance with environmental standards and requirements, both radiological and nonradiological; discusses the status of the Environmental Management System (EMS); describes significant accomplishments of pollution prevention activities; reports data for effluent and ambient air and water monitoring; reports radiological doses; summarizes LLNL's activities involving special status wildlife and plants; and describes the progress made in remediating groundwater contamination. The report demonstrates LLNL's continuing commitment to the protection of the public and the environment. The report is available on the Internet at http://www.llnl.gov/saer/.

Major LLNL Programs

The University of California manages LLNL for the National Nuclear Security Administration (NNSA) within DOE. LLNL was established in 1952 in Livermore to ensure national security through the design, development, and stewardship of nuclear weapons; operations at Site 300, LLNL's experimental test site, began in 1955.

LLNL plays a prominent role in NNSA's Stockpile Stewardship Program, in which laboratory scientists and engineers ensure the safety and reliability of the nation's nuclear weapons and certify weapon performance without nuclear testing. At LLNL, nuclear weapons expertise and extensive capabilities in physical and life sciences are applied to meet the challenge of the proliferation of weapons of mass destruction and to protect the nation from terrorism. Analytical support and advanced technologies are provided by LLNL to the Department of Defense, the intelligence community, and other agencies.

Reinforcing the national security mission, LLNL pursues research and development in other areas of importance. Using LLNL's physical science, computing, and engineering capabilities, bioscience research is directed at understanding causes and mechanisms of ill health, developing biodefense capabilities, improving disease prevention, and helping lower health costs. Long-term research is carried out to provide the nation with abundant, reliable energy and a clean environment. LLNL scientists and engineers also pursue projects in fundamental science and applied technology that take advantage of the unique research capabilities and facilities at LLNL.

Other Key Initiatives

Safe, secure, and efficient operations that provide a safe, clean environment for employees and neighboring communities are a necessary part of the Laboratory's research and development programs and underpin their success. Experts in environment, safety and health (ES&H) within the Safety and Environmental Protection Directorate support all Laboratory activities. A high-quality radiological control program at LLNL ensures that radiological exposures and releases are reduced to as low as reasonably achievable to protect the health and safety of all its employees, contractors, the general public, and the environment.

Over the last two decades, LLNL has made great strides in improving its environmental performance and has actively taken steps to reduce any potential impacts the Laboratory's operations might have on the environment and the community.

The Laboratory encourages participation by the public on matters related to its environmental impact on the community by initiating communications and providing opportunities for citizens to give input to the decision-making process on matters of significant public interest. It also provides access to information on its ES&H activities.

All environmental monitoring and analysis of samples and data, including the preparation of this report, are conducted under the Environmental

Protection Department's Quality Assurance Management Plan. This plan is included under LLNL's Quality Assurance Policy, with its commitment to effectiveness, excellence, innovation, and continuous quality improvement.

LLNL's Environmental Management System

In 1998, LLNL began the process of developing and implementing an Integrated Safety Management System (ISMS) in accordance with the University of California's Prime Contract W-7405-ENG-48, Clause 6.7. The ISMS ensures the systematic integration of ES&H considerations into management and work practices so that missions are accomplished safely. Work Smart Standards (WSS), based on applicable laws, regulations, and DOE orders, establish workplace ES&H controls and are an integral part of LLNL's ISMS. The University of California and the Department of Energy require LLNL to have an Environmental Management Program (EMP) as part of the WSS.

In June 2004, LLNL enhanced its EMP by adopting the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management System (EMS) as a WSS; on July 22, 2004, the LLNL Director issued an Administrative Memo defining LLNL's Environmental Policy. An internal EMS audit was held November 9 and 10, 2005. Subsequently, the Livermore Site Office (LSO) of the DOE conducted an independent evaluation of LLNL's EMS. On December 20, 2005, LSO/DOE issued a draft Corrective Action Plan to address the minor nonconformances identified in the LSO audit. On December 22, 2005, LLNL, per agreement with LSO/DOE, self-declared its conformance with ISO 14001:1996.

In December 2005, nine EMP documents were completed that describe different environmental aspects[1]. These include Ecological Resource Disturbance, Electrical Energy Use, Fossil Fuel Consumption and Renewable Energy, Hazardous Materials Use Study and Evaluation, Mixed Waste, Municipal Waste Generation, Nonhazardous Materials Use, Radioactive Materials Use, and Transuranic Use Generation. Each document lists the objectives and targets and the responsible individuals for each category

During 2006, LLNL is implementing the corrective actions that address the deficiencies identified in the DOE/LSO audit and is starting to update the present EMS to meet the requirements of ISO 14001:2004.

1 Environmental aspects are elements of an organization's activities, products or services that can interact with the environment.

The EMS commits LLNL—and each employee—to responsible stewardship of all the environmental resources in our care. To educate all LLNL employees, the Environmental Protection Department distributed a brochure (UCRL-BR-216486) describing EMS. An LLNL website that describes the LLNL EMS can be accessed at http://www-epd.llnl.gov/ems/ems_logo.htm.

Pollution Prevention

A strong Pollution Prevention (P2) Program is an essential element of LLNL's EMS. The P2 team is responsible for P2 program stewardship and maintenance, waste stream analysis, reporting of waste generation, and coordination of institutional P2 programs and activities.

In December 2005, DOE NNSA selected two projects at LLNL to receive DOE Best-in-Class awards. The first of the awards was for the Space Action Team's initiative that provides a contractual mechanism for converting the value of equipment or building materials into an offset against payment for demolition work. The second award was for the replacement of the greenhouse/asphyxiant gas sulfur hexafluoride with ultra-zero compressed air for use as a dielectric in a portable flash x-ray system used at the Experimental Explosive Facility at Site 300. Both projects reduce LLNL's impact on the environment and save money. Another project, the Joint Actinide Shock Physics Experiment Research (JASPER), managed by LLNL at the Nevada Test Site, also received a Best-in-Class award for the incorporation of waste minimization and pollution prevention into the design, execution and maintenance of the project.

A DOE Environmental Stewardship award was issued to the Contained Firing Facility at Site 300 for the development and implementation of an inexpensive low-tech method of particulate capture combined with an extensive water recycling and polishing system that clean the facility after each experiment while reducing wastewater, saving worker time, and increasing safety.

LLNL also conducted activities to promote employee awareness of P2. These included the annual Earth Expo held in April, articles in the LLNL newspaper, and training for purchasing staff. A P2 resource is the website http://www-p2.llnl.gov/.

Regulatory Permitting and Compliance

LLNL undertakes substantial activities to comply with the many federal, state, and local environmental laws. The major permitting and regulatory activities that LLNL conducts are required by the Clean Air Act; the Clean Water Act and related state programs; the Emergency Planning and Community Right-to-Know Act, the Resource Conservation and Recovery Act and state and local hazardous waste regulations; the National Environmental Policy Act and the California Environmental Quality Act; the Endangered Species Act; the National Historic Preservation Act; the Antiquities Act; and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

In 2005, LLNL held many permits for many activities and hosted numerous inspections and tours by outside agencies. Overall, LLNL has an excellent record with very few notices of violations and permit nonconformances during 2005. A high pH excursion in LLNL's sanitary sewer discharge resulted in the only environmental occurrence report for 2005.

Air Monitoring

Releases of radioactivity to the environment from LLNL operations occur through stacks and from diffuse area sources. In 2005, radioactivity released to the atmosphere was monitored at 71 sampling locations at six facilities on the Livermore site and one at Site 300. There were no releases from the HEPA-filtered monitored stacks at the Livermore site. Stack releases of tritium from the Tritium Facility and the Decontamination and Waste Treatment Facility contributed 85% of the estimated of 1.5 TBq (40.5 Ci) of tritium released from the Livermore site in 2005. The 2005 tritium release rate is essentially equal to the release rate in 2004, but, in 2005, the fraction of total tritium contributed by diffuse area sources was greater than in 2004. At Site 300, only very small quantities of gross alpha and gross beta radiation associated with particles (fewer than 6×10^{4} Bq [1.6×10^{-6} Ci] each) were estimated very conservatively to have been released from the Contained Firing Facility during 2005.

The magnitude of nonradiological releases (e.g., reactive organic gases/precursor organic compounds, nitrogen oxides, carbon monoxide, particulate matter, sulfur oxides) is estimated based on specifications of equipment and hours of operation. Estimated releases in 2005 for the Livermore site were within about 10% of those in 2004; estimated releases at Site 300 were consistently lower than in 2004. Nonradiological releases from

LLNL continue to be a very small fraction of releases from the Bay Area or San Joaquin County

In addition to effluent monitoring, LLNL samples ambient air for tritium, radioactive particles, and beryllium. Some samplers are situated specifically to monitor areas of known contamination, some monitor potential exposure to the public, and others, distant from the sites, monitor natural background. In 2005, ambient air monitoring data confirmed estimated releases from monitored stacks and were used to determine source terms for resuspended plutonium-contaminated soil and tritium diffusing from area sources at the Livermore site and resuspended uranium-contaminated soil at Site 300.

The wildfire that burned 2100 acres of Site 300 in July 2005 released approximately 21 tons of particulate matter (PM) and 0.4 tons of nitrogen oxides (NOx). Because Site 300 is regularly burned under permit to prevent wildfires that may result from operations, the fire did not spread. As a result, the quantities of PM and NOx released by the fire were estimated at less than 20% of what they might have been had the fire spread. Concentrations of gross alpha, gross beta, and uranium after the fire were similar to those seen after prescribed burns and were due to increased mass loading of the filters due to resuspension of particles during the fire.

Water Monitoring

Monitoring of various categories of water is carried out to determine if any radioactive or nonradioactive hazardous contaminants released by LLNL might have a negative impact on public health and the environment.

Permits, including one for discharging treated groundwater from the Ground Water Project, regulate discharges to the City of Livermore sanitary sewer system. There was one Notice of Violation (NOV) in 2005 from the Livermore Water Reclamation Plant (LWRP) for exceeding the maximum pH limit of 10. Approximately 300–600 gallons of effluent with a pH of 11.6 were discharged to the LWRP; the remainder of the effluent was captured and contained on site by the Sewer Diversion Facility. This incident was reportable under DOE Order 232.1A. No discharges exceeded any discharge limits for release of radioactive materials to the sewer, and only one other pH excursion occurred during 2005. All discharges from the Site 300 sewage evaporation pond to the percolation pond, as well as discharges to the surface impoundments, were in compliance with discharge limits.

Storm water is sampled for contaminants such as radioactivity, metals, oxygen, dioxins, polychlorinated biphenyls (PCBs), and nitrate both upstream and downstream from both sites to determine the impact of each site. Data show that storm water downstream of Livermore site has not been impacted

by LLNL activities; at Site 300, concentrations of monitored constituents—including lead, uranium, and dioxins—in the downstream waters of Corral Hollow Creek are similar to those upstream of Site 300.

Extensive monitoring of groundwater occurs at and near the Livermore site and Site 300. Groundwater from wells downgradient from the Livermore site is analyzed for pesticides, herbicides, radioactivity, nitrates and hexavalent chromium. To detect any offsite contamination quickly, the well water is sampled in the uppermost water-bearing layers. As in other years, all contaminants in groundwater away from the Livermore site were well below allowable limits for drinking water. Near Site 300, monitored constituents for offsite groundwater include explosives residue, nitrate, perchlorate, metals, volatile and semivolatile organic compounds, tritium, uranium, and other (gross alpha and beta) radioactivity. One groundwater sample collected from an offsite private well about six kilometers to the west of Site 300 had nitrate concentrations slightly above the drinking water limit (45 mg/L). This result appears to be unrelated to LLNL activities. No other constituent reached any drinking water limit in offsite wells near Site 300.

Rainwater is analyzed for tritium. Concentrations in rain samples may be highly variable depending upon operations taking place during the rain. In 2005, the maximum concentration of tritium in rain collected on the Livermore site was 1.6% of the drinking water standard of 740 Bq/L (20,000 pCi/L), and no offsite concentrations were above the lower limit of detection (0.5% of the drinking water standard). At Site 300, all rain samples were below detection limits.

Surface waters and drinking water are analyzed for tritium, gross alpha, and gross beta radioactivity. In the Livermore Valley, there were no tritium measurements above the detection limit, median gross alpha measurements were below detection limits, and the median gross beta concentration was less than 6% of the drinking water standard of 1.85 Bq/L (50 pCi/L). The onsite surface water in the Drainage Retention Basin (DRB) exhibited levels of gross alpha, gross beta, tritium, metals, organics, pesticides and PCBs that were well below discharge limits; aquatic bioassays for acute and chronic toxicity showed no toxicity effects in DRB discharge water. At Site 300, maintenance on the drinking and cooling water systems resulted in permitted discharges to ground without adverse impact on surrounding waters.

Groundwater Remediation

Groundwater at both the Livermore site and Site 300 is contaminated from historical operations; both are undergoing CERCLA cleanup. At the Livermore site, contaminants include volatile organic compounds (VOCs),

fuel hydrocarbons, metals, and tritium, but only the VOCs in groundwater and saturated and unsaturated soils need remediation. Cleanup began in 1989. Site 300 cleanup began in 1991. VOCs are the main contaminant found at the eight Site 300 Operable Units (OUs). In addition, nitrate, perchlorate, tritium, high explosives, depleted uranium, organosilicate oil and metals are found at one or more of the OUs.

The present contamination, for the most part, is confined to each site. In 2005, concentrations continued to decrease in most of the Livermore site VOC plumes due to active remediation and the removal of over 267 kg of VOCs from both groundwater and soil vapor. VOC concentrations on the western margin of the site continued their gradual decline, indicating effective hydraulic control of the boundary plumes. Within the interior of the site, remediation activities, including soil vapor extraction, dual extraction, and groundwater extraction, have resulted in declines of VOC concentrations in numerous source areas. Of special interest is the significant five-fold increase in the mass of VOCs removed from soil vapor during the past four years.

In 2005 at Site 300**,** perchlorate, nitrate, the high explosive RDX, and organosilicate oil were removed from groundwater in addition to about 90 kg of VOCs. Each OU has a different profile of contaminants, but, overall, groundwater and soil vapor extraction and natural attenuation at Site 300 continue to reduce the mass of contaminants in the subsurface. The cleanup of volatile organic compounds was completed at the Site 300 General Services Area. An additional four areas are under investigation and have not yet reached a final CERCLA remedy to address environmental contamination.

Terrestrial Radiological Monitoring

The impact of LLNL operations on surface soil, sediment, and vadose zone soils in 2005 was insignificant. Soils and sediments are analyzed for plutonium, gamma-emitting radionuclides, tritium, total and soluble metals, and PCBs as appropriate. Plutonium concentrations at the Livermore Water Reclamation Plant continued to be high relative to any other sampled location, but even this concentration was only 2% of the screening level for cleanup recommended by the National Council on Radiation Protection (NCRP). At Site 300, soils are analyzed for gamma-emitting radionuclides and beryllium. In 2005, uranium-238 concentrations in soils at Site 300 were below NCRP recommended screening levels.

Vegetation and Livermore Valley wine were sampled for tritium. In 2005, the median concentrations of all offsite vegetation samples were below the lower limit of detection of the analytical method. The mean concentration in Livermore Valley wines, at about 0.2% of the drinking water standard, was a

factor of three times lower than concentrations in wines from the Rhone Valley in France.

LLNL's extensive network of thermoluminescent dosimeters (TLDs) measures the natural terrestrial and cosmogenic background; in 2005, as in recent years, no impact of LLNL operations was detected.

Multimedia Comparison

In **Figure EX-1**, annual median concentrations of tritium in air moisture[1] at location VIS (see **Figure 6-1**), in water in the Drainage Retention Basin (DRB; see **Figure 4-9**), and in wine from the Livermore Valley over the last ten years are compared with background levels of tritium in rain (measured at Portland, Oregon, and Anchorage, Alaska) and California wine (excluding the Livermore Valley), and with total tritium releases to the atmosphere from the Livermore site. Concentrations of tritium in air moisture at VIS and water from the DRB in 2005 were less than 0.7% of the Environmental Protection Agency's drinking water standard of 740 Bq/L (20,000 pCi/L).

Generally, the correlation between concentrations in environmental media and annual releases of tritium to the atmosphere from LLNL is weak. Differences are due to distance from the tritium sources to the location of the sampled medium, whether the released tritium was from a stack or from an area source, the fraction of time the wind blew towards the location, and how well the sample medium integrated tritium concentrations throughout the year. Nevertheless, a reasonable correlation may be seen between the concentrations in air moisture and those in the DRB. Concentrations in Livermore Valley wine can vary independently of release rates because of random sampling of wines made from grapes grown at various distances from the sources of tritium at the Livermore site.

Background tritium levels seen in rain from Portland and Anchorage include cosmogenic tritium and residual tritium from bomb tests. These background tritium levels show large variability because of latitude-effects and distance from large bodies of water. California wines and rain in Portland exhibit similar tritium concentrations.

1 Air moisture is collected by the sampling medium. Concentrations of tritium in air (see Chapter 4) are calculated by dividing the total tritium collected by the volume of air passed through the sampler.

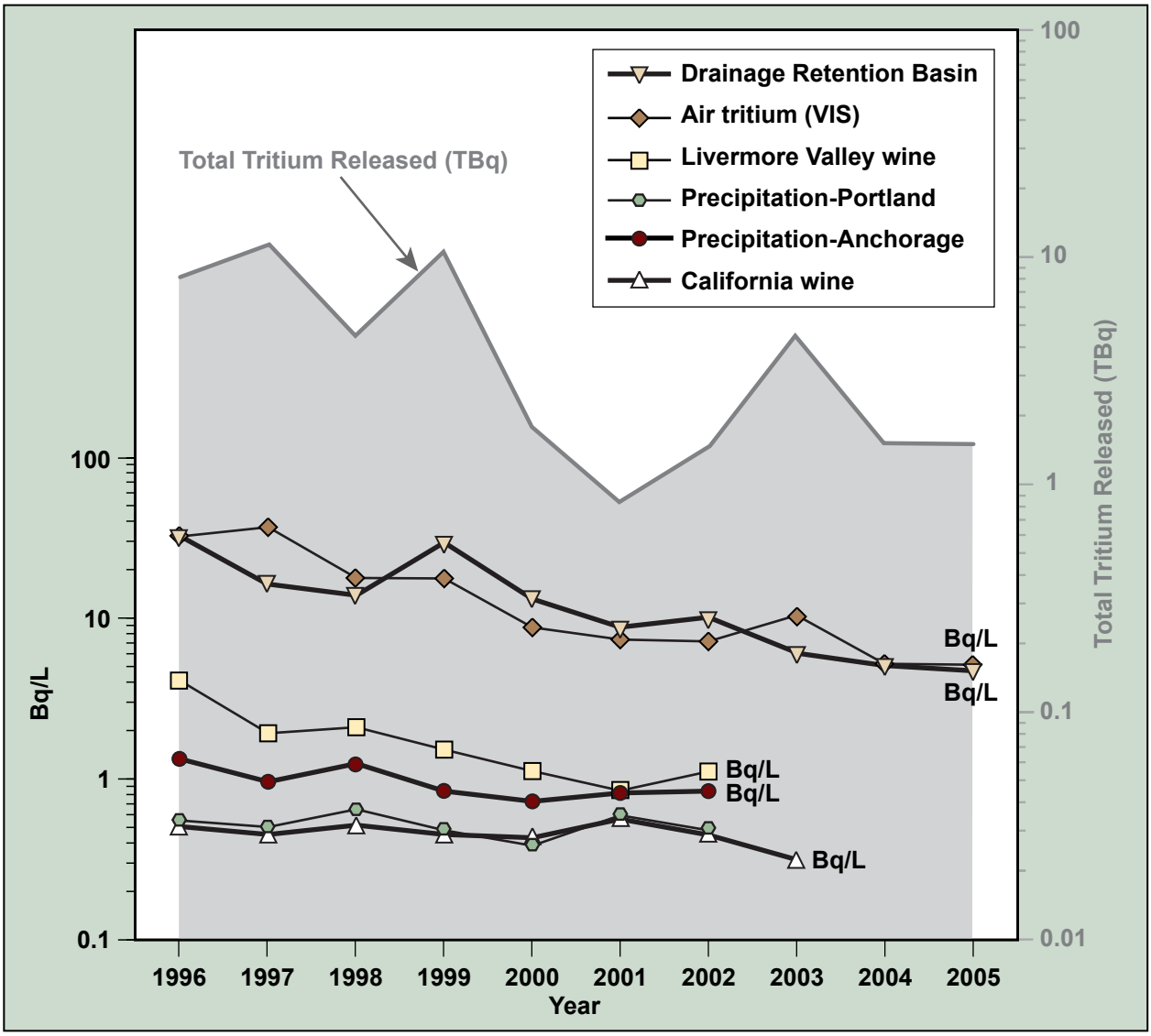

Figure EX-1. Annual median concentrations of tritium in three LLNL media compared with natural background (e.g., precipitation) and total annual releases of tritium from LLNL.

Biota

LLNL studies, preserves, and tries to improve the habitat of five species at Site 300 that are covered by the federal or California Endangered Species Acts (California tiger salamander, California red-legged frog, Alameda whipsnake, valley elderberry longhorn beetle, and the large-flowered fiddleneck) as well as rare species or those of special interest otherwise. At Site 300, LLNL also monitors populations of birds and rare species of plants. The red-legged frog is also protected on the Livermore site.

At Site 300, red-legged frogs were translocated to two new pools that were created to replace wetlands maintained artificially by discharge from several buildings, and a new seasonal pool was created for the tiger salamander after the removal of Class II impoundments. At the DRB, adult bullfrogs and egg masses were removed. LLNL employees are being educated about the illegality of releasing any non-native animal to the DRB or of fishing in the DRB, what animals are not native (e.g., bullfrogs and large-mouth bass, both current residents of the DRB), the threat these introduced predators pose to the red-legged frog, and the cost of eliminating them from the DRB. In early 2006, a brochure (UCRL-BR-217784) discussing these issues was distributed to all employees; also in early 2006, there was an article in NewsOnLine and an "LLNL Lessons Learned" was distributed. In addition, a series of eight posters (UCRL-POST-213624) were placed around the DRB to educate LLNL employees and visitors about the history and ecology of the "Laboratory's Basin." Algal blooms are explained, and dragonflies, frogs, toads, and muskrat are profiled colorfully and informatively.

The 2005 radiological doses calculated for biota at the Livermore site or at Site 300 were far below screening limits set by DOE, even though extremely unlikely assumptions maximized the potential effect of LLNL operations on biota.

Radiological Dose

Dose calculated to the site-wide maximally exposed individual (SW-MEI) for 2005 was 0.065 μSv (0.0065 mrem) for the Livermore Site and 0.18 μSv (0.018 mrem) at Site 300. Four sources of tritium at LLNL contributed nearly 100% of the dose received by the SW-MEI. The dose for 2005 was about 80% of the 2004 dose for the Livermore site. At Site 300, the shots at the Building 851 firing table contributed 48% of the dose; resuspended uranium-contaminated soil contributed the remainder of the dose. The dose to the SW-MEI at Site 300 was about 70% of the 2004 dose because doses are more or less proportional to the number of shots in a year. There were no unplanned releases to the atmosphere from either site.

In **Figure EX-2**, calculated radiological doses to the SW-MEI from operations at each site in 2005 are compared with regulatory limits and doses potentially received from the environment or from common activities (e.g., medical x-rays). The contribution of LLNL operations to unavoidable dose was inconsequential.

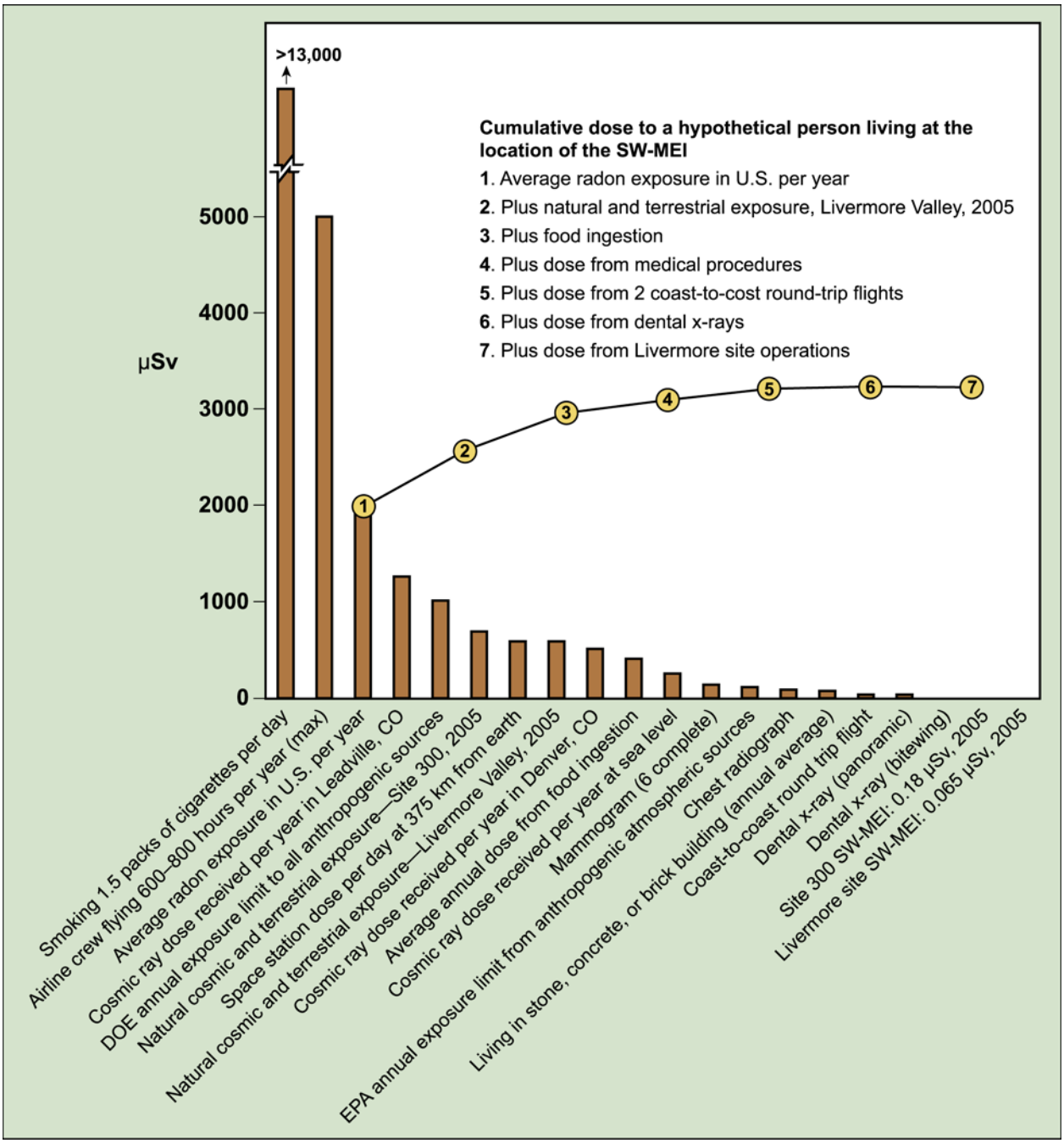

Figure EX-2. Doses from the Livermore site and Site 300 operations compared with doses potentially received by an average individual. Dose to a hypothetical member of the public living at the perimeter of the Livermore site is also demonstrated.

Conclusion

The combination of surveillance and effluent monitoring, source characterization, and dose assessment showed that the radiological dose to the most-exposed member of the public caused by LLNL operations in 2005 was less than 0.2% of regulatory standards and more than 16,000 times smaller than dose from natural background. Potential dose to biota was well below DOE screening limits. LLNL demonstrated good compliance with permit conditions for releases to air and to water. Analytical results and evaluations of air and various waters potentially impacted by LLNL operations generally showed a minimal contribution from LLNL operations. Remediation efforts at both the Livermore site and Site 300 further reduced concentrations of contaminants of concern in groundwater and soil vapor.

The Agency for Toxic Substances and Disease Registry released their final Public Health Assessment (PHA) for LLNL in 2005. This PHA was specific to Site 300, but the conclusion of "No Public Health Hazard" was similar to the conclusion of ATSDR's 2004 PHA for the Livermore site. Clearly, LLNL's environmental program demonstrates a commitment to protecting the environment by controlling pollutants.